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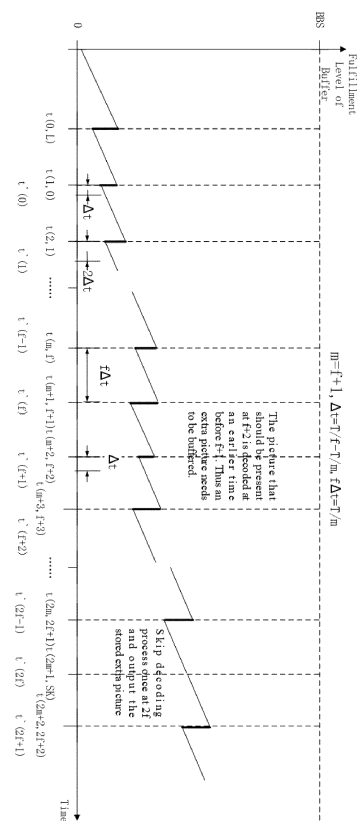
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(54) **BITSTREAM CHECKING AND DECODING METHOD, AND DEVICE THEREOF**

(57) Disclosed in the present invention is a method of bitstream verifying. At the encoder side, the coded picture data of a spliced bitstream, combined with library bitstream and main bitstream, is processed by different operations in the hypothetical bitstream buffer to simulate the data fulfillment level of the bitstream buffer. This is used to check whether the hypothetical bitstream buffer is overflowed or underflowed and verify the qualification of the bitstream. The purpose of the verifying method is to check whether a bitstream produced by an encoder meets the constraint of the buffer. At the decoder side, a mechanism of managing bitstream corresponding to the present method of bitstream verifying is exploited to decode the library picture, which is inserted in the spliced bitstream, at a proper time. This ensures that a bitstream buffer with a limited capacity neither overflows nor underflows and the decoder can decode and present the picture of the main bitstream at a proper temporal order. The decoding method provided by the present invention can sequentially decode the library picture and the main bitstream picture by using a buffer with limited capacity, which avoids lag of the main bitstream picture and waste of the decoded picture buffer.



## Description

### FIELD OF THE INVENTION

**[0001]** This invention relates to the field of image or video compression, and more typically. More specifically, the present invention relates to methods and apparatus of bitstream verifying and decoding.

### BACKGROUND

#### 1. Conventional video coding methods

**[0002]** In conventional video coding, video sequence is divided into multiple Random Access Segment (RAS) which supports random access functionality from the segment. As shown in the Figure 1, a video sequence contains one or multiple RASs, each of which covers one presentation duration and contains one Random Access Point (RAP) picture and several non-RAP pictures. Every picture has its own presentation time that indicates the time when the picture should be present or displayed. Picture in a RAS can be intra coded or inter coded by referencing to other pictures in the same RAS, where the reference picture can be present pictures or non-present synthesized picture, and so on. However, in the conventional methods, a picture, whose presentation time follows that of the RAP picture, is restricted to only reference to the other pictures belonging to the same RAS as the current picture does. As for the pictures ahead of or after the RAS corresponding to the current picture, they cannot be referenced to by the current picture, as shown in the Figure 1. Typically, there are several methods to describe the dependency relation between the current picture and its reference picture candidates:

In the conventional video coding schemes, such as H.264/AVC and H.265/HEVC, the dependency relation between current picture and its reference picture candidates are signaled by reference picture configuration set in the video coding layer, wherein the reference picture configuration set records the difference numbers between the number of current picture and those of its reference pictures. The reason of only recording the difference numbers in the reference picture configuration set is that, in the conventional video coding methods, the current picture and its reference picture candidates belong to the same RAS that can be decoded independently, and the numbers of the current picture and its reference picture candidates conform to the same numeration principle, e.g. numbered in temporal order. Thus, the difference number is enough to correctly identify the target reference picture candidate. If the current picture and its reference picture use different numeration principles, the same difference number would point to a different reference picture candidate from the one when they use the same numeration principles, because the conventional video coding methods do not provide means to signal the different numeration principles. When this

happens, the encoder and decoder cannot find the correct reference picture candidate.

**[0003]** In Scalable Video Coding (SVC) and Multiview Video Coding (MVC), as shown in Figure 2, SVC/MVC introduce inter-layer/inter-view prediction, based on the inter prediction which only use reference picture candidate belonging to the same layer/view, to extend the range of the reference picture candidates. The extended reference picture candidates have the same number, e.g. the same timestamp, and belongs to different layers of an independently decodable segment. SVC/MVC indicate the dependency relation between different layers/views via layer flag together with the number that is same as the current coded picture. In the scene picture based video coding in AVS2, as shown in Figure 3, the dependency relation between coded picture and the scene picture is signaled by the flag of the type of the reference picture. Typically, AVS2 exploits flag to signal the special types of scene pictures, i.e. G picture and GB picture. The G/GB pictures are managed inside a special reference picture buffer, i.e. scene picture buffer. A flag is introduced to signal whether the current picture references to a G/GB picture. A special reference picture set construction method is designed, i.e. the G/GB picture is always put in the last position of the reference picture set. As a consequence, the above mechanism makes it possible for the current coded picture, which is numbered in numeration principle, to find the 1) GB picture, which is not numbered in numeration principle, or 2) G picture, which is beyond the restricted reference range of the current picture although is numbered in numeration principle, and use the G/GB picture as reference. However, the above method restricts that only one scene picture exists in the scene picture buffer at any time, and, meanwhile, the single scene picture must be inside the same RAS that containing the current picture.

#### 2. Library-Based Video Coding

**[0004]** The mentioned mechanism of conventional methods would limit the number of reference pictures that can be used by the current coding picture, which could not efficiently improve the coding gain of picture encoding and decoding.

**[0005]** In order to make full use of the mutual information between multiple RASs in picture encoding, the encoder/decoder can select picture, from library, which has the similar texture content with the current encoding/decoding picture as reference picture when encoding/decoding the current picture. The special reference picture from library is referred to as library picture and the dataset storing the library picture as library. The method of allowing that one or multiple pictures in a video sequence uses one or multiple library pictures as reference picture for encoding/decoding is named as library-based video coding. Encoding a video sequence with the library-based video coding method generates a library layer bitstream containing the coded library picture and a video layer

bitstream containing the coded video sequence picture. The mentioned two kinds of bitstreams is similar as the base layer bitstream and the enhancement layer bitstream in SVC (Scalable Video Coding), i.e. the video layer bitstream depends on the library layer bitstream. However, the management of the two bitstream generated by the library-based video coding method is different from the layered bitstream generated by SVC. The difference is that the layered bitstreams in SVC are synchronized based on a same timeline, while the two bitstreams in library-based video coding are not synchronized based on the same timeline but are synchronized based on explicitly signaling.

**[0006]** In the library-based video coding, library picture is obtained and exploited as extra reference picture candidate for the picture encoding/decoding. Figure 4 depicts the dependency relation between sequence picture and library picture while in using the library-based video coding method. Library picture makes it possible for the sequence picture to exploit the mutual information from a large-scale range of temporal domain, which improves the coding efficiency. However, the conventional library-based video coding method could not efficiently support the signaling of dependency relation between the sequence pictures and library pictures as well as the efficient management of library picture.

### 3. Conventional bitstream buffer verification methods

**[0007]** In the conventional technologies, bitstream verification methods verifies the bitstream in the hypothetical bitstream buffer. For example, in Fig. 5, the bitstream data gets into the hypothetical bitstream buffer sequentially and is moved out from the bitstream buffer for decoding at the decoding time instant  $t(n)$ . A bitstream conforming to the verification should ensure that the data level of the hypothetical bitstream buffer is no larger than the capacity of the buffer, i.e. the buffer is not overflowed, and is no less than the necessary data size required for decoding at the current time instant, i.e. the buffer is not underflowed.

### DETAILED DESCRIPTION OF THE PRESENT INVENTION

**[0008]** To overcome the mentioned problems of the conventional methods, this invention discloses methods and apparatus of bitstream verifying. At the encoder side, the coded picture data of a spliced bitstream, combined with library bitstream and main bitstream, is processed by different operations in the hypothetical bitstream buffer to simulate the data fulfillment level of the bitstream buffer. This is used to check whether the hypothetical bitstream buffer is overflowed or underflowed and verify the qualification of the bitstream. The purpose of the verifying method is to check whether a bitstream produced by an encoder meets the constraint of the buffer.

**[0009]** The first aspect of the present invention pro-

vides a method of bitstream verifying, comprising:

1) For the coded data of a current picture in a bitstream combined with main bitstream and library bitstream, executing one of the following operations:

- a. If the current picture belongs to the main bitstream, deciding whether to move the coded data of the current picture out from a hypothetical bitstream buffer or not according to the difference value between the decoding time instant of the current picture and the presentation time instant of a previous picture that has been decoded before the current picture, wherein the previous picture belongs to the main bitstream;
- b. If the current picture belongs to the library bitstream, moving the coded data of the current picture out from the hypothetical bitstream buffer, according to the decoding time instant of the current picture;

2) Checking the data fulfillment level of the hypothetical bitstream buffer, verifying whether the said bitstream meet the constraint of the buffer, according to whether the data fulfillment level exceeds the upper limit and lower limit of the capacity of the hypothetical bitstream buffer.

**[0010]** In another example of the present method, the operation of deciding whether to move the coded data of the current picture out from a hypothetical bitstream buffer or not according to the difference value between the decoding time instant of the current picture and the presentation time instant of a previous picture that has been decoded before the current picture, is further executing one of the following operations:

- 1) If the decoding time instant of the current picture is not earlier than the presentation time instant of a second previous picture that is the second nearest one decoded before the current picture, moving the coded data of the current picture out from the hypothetical bitstream buffer at the decoding time instant of the current picture;
- 2) If the decoding time instant of the current picture is earlier than the presentation time instant of a second previous picture that is the second nearest one decoded before the current picture, do not move coded data out from the hypothetical bitstream buffer at the decoding time instant of the current picture.

**[0011]** The second aspect of the present invention is to decode the library picture, which is inserted in the spliced bitstream, at a proper time by exploiting a mechanism of managing bitstream at the decoder side, wherein the mechanism corresponds to the present method of bitstream verifying. This ensures that a bitstream buffer with a limited capacity neither overflows nor underflows

and the decoder can decode and present the picture of the main bitstream at a proper temporal order. The decoding method provided by the present invention can sequentially decode the library picture and the main bitstream picture by using a buffer with limited capacity, which avoids lag of the main bitstream picture and waste of the decoded picture buffer.

**[0012]** For the above purpose, the present invention provides a method of decoding which executes one of the following operations for the coded data of a current picture in a bitstream storing in a bitstream buffer, wherein the said bitstream is combined with main bitstream and library bitstream:

- a. If the current picture belongs to the main bitstream, deciding whether to move the coded data of the current picture out from the bitstream buffer for decoding or not according to the difference value between the decoding time instant of the current picture and the presentation time instant of a previous picture that has been decoded before the current picture, wherein the previous picture belongs to the main bitstream;
- b. If the current picture belongs to the library bitstream, moving the coded data of the current picture out from the bitstream buffer for decoding, according to the decoding time instant of the current picture.

**[0013]** In another example of the present method, the operation of deciding whether to move the coded data of the current picture out from the bitstream buffer for decoding or not according to the difference value between the decoding time instant of the current picture and the presentation time instant of a previous picture that has been decoded before the current picture, is further executing one the of the following operations:

- 1) If the decoding time instant of the current picture is not earlier than the presentation time instant of a second previous picture that is the second nearest one decoded before the current picture, moving the coded data of the current picture out from the bitstream buffer for decoding at the decoding time instant of the current picture, and moving the decoded current picture into a to-be-present buffer;
- 2) If the decoding time instant of the current picture is earlier than the presentation time instant of a second previous picture that is the second nearest one decoded before the current picture, do not move coded data out from the bitstream buffer at the decoding time instant of the current picture.

**[0014]** In another example of the present method, the operation of moving the decoded current picture into a to-be-present buffer is executing one of the following operations:

- 1) If the decoding time instant of the current picture is not earlier than the presentation time instant of a

first previous picture that is the first nearest one decoded before the current picture, moving the said decoded current picture into a first to-be-present buffer;

2) If the decoding time instant of the current picture is not earlier than the presentation time instant of the second previous picture that is the second nearest one decoded before the current picture and is earlier than the presentation time instant of the first previous picture that is the first nearest one decoded before the current picture, moving a decoded picture from a second to-be-present buffer into the first to-be-present buffer and moving the said decoded current picture into the second to-be-present buffer.

**[0015]** In another example of the present method, the decoded version of the current picture is moved into a library picture buffer if the current picture belongs to the library bitstream.

**[0016]** The third aspect of the present invention provides an apparatus of bitstream verifying, comprising:

- A processor,
- A memory, and

**[0017]** One or more programs executing the following methods:

1) For the coded data of a current picture in a bitstream combined with main bitstream and library bitstream, wherein the said bitstream is stored in the memory, the processor executes one of the following operations:

- a. If the current picture belongs to the main bitstream, the processor decides whether to move the coded data of the current picture out from a hypothetical bitstream buffer or not according to the difference value between the decoding time instant of the current picture and the presentation time instant of a previous picture that has been decoded before the current picture, wherein the previous picture belongs to the main bitstream;
- b. If the current picture belongs to the library bitstream, the processor moves the coded data of the current picture out from the hypothetical bitstream buffer, according to the decoding time instant of the current picture;

2) The processor checks the data fulfillment level of the hypothetical bitstream buffer, verifies whether the said bitstream is qualified, according to whether the data fulfillment level exceeds the upper limit and lower limit of the capacity of the hypothetical bitstream buffer.

**[0018]** In another example of the present apparatus,

the processor deciding whether to move the coded data of the current picture out from a hypothetical bitstream buffer or not according to the difference value between the decoding time instant of the current picture and the presentation time instant of a previous picture that has been decoded before the current picture, is executing one of the following operations:

- 1) If the decoding time instant of the current picture is not earlier than the presentation time instant of a second previous picture that is the second nearest one decoded before the current picture, the processor moves the coded data of the current picture out from the hypothetical bitstream buffer at the decoding time instant of the current picture;
- 2) If the decoding time instant of the current picture is earlier than the presentation time instant of a second previous picture that is the second nearest one decoded before the current picture, the processor does not move coded data out from the hypothetical bitstream buffer at the decoding time instant of the current picture.

**[0019]** The fourth aspect of the present invention provides an apparatus of decoding, comprising:

- A processor,
- A memory, and

**[0020]** One or more programs executing the following methods:

The processor executes one of the following operations for the coded data of a current picture in a bitstream entering into a bitstream buffer in the memory, wherein the said bitstream is combined with main bitstream and library bitstream:

- a. If the current picture belongs to the main bitstream, the processor decides whether to move the coded data of the current picture out from the bitstream buffer for decoding or not according to the difference value between the decoding time instant of the current picture and the presentation time instant of a previous picture that has been decoded before the current picture, wherein the previous picture belongs to the main bitstream;
- b. If the current picture belongs to the library bitstream, the processor moves the coded data of the current picture out from the bitstream buffer for decoding, according to the decoding time instant of the current picture.

**[0021]** In another example of the present apparatus, the processor deciding whether to move the coded data of the current picture out from the bitstream buffer for decoding or not according to the difference value between the decoding time instant of the current picture and the presentation time instant of a previous picture

that has been decoded before the current picture, is executing one of the following operations:

- 1) If the decoding time instant of the current picture is not earlier than the presentation time instant of a second previous picture that is the second nearest one decoded before the current picture, the processor moves the coded data of the current picture out from the bitstream buffer for decoding at the decoding time instant of the current picture, and moves the decoded current picture into a to-be-present buffer;
- 2) If the decoding time instant of the current picture is earlier than the presentation time instant of a second previous picture that is the second nearest one decoded before the current picture, the processor does not move coded data out from the bitstream buffer at the decoding time instant of the current picture.

## **BRIEF DESCRIPTION OF THE DRAWINGS**

**[0022]** In order to clearly explain the embodiments or the conventional methods, drawings of the embodiments or the conventional methods are briefly introduced. Obviously, the following drawings are only for some embodiments of this invention. For those experts in this field, other drawings can be obtained according to the present drawings without any creative work.

Figure 1 Example of the dependency relation of the video sequence when coded with the conventional method 1, wherein the sequence is fragmented into multiple RASs.

Figure 2 Example of the dependency relation of the video sequence when coded with the conventional method 2, wherein the sequence is fragmented into multiple RASs.

Figure 3 Example of the dependency relation of the video sequence when coded with the conventional method 3, wherein the sequence is fragmented into multiple RASs.

Figure 4 Example of the dependency relation of the video sequence when coded with the conventional method 4, wherein the sequence is fragmented into multiple RASs.

Figure 5 Example of the change of the data level of a bitstream buffer using conventional method of bitstream buffer verification.

Figure 6 Example of the change of the data level of a bitstream buffer using a present method of bitstream buffer verification provided by the exemplary embodiment of the present invention.

Figure 7 Example of the change of the data level of a bitstream buffer using another present method of bitstream buffer verification provided by another exemplary embodiment of the present invention.

## DETAILED EMBODIMENTS

[0023] To make the purpose, technical methods and advantages of this invention more clear, the followings demonstrate detailed embodiments of this invention with the assistance of the drawings.

### Definition of Terms:

[0024] Necessary terms are defined before the explanation of detailed embodiments:

Library picture: is a picture that does not belong to the set of the pictures, which need to be present, in the current random access segment (RAS) containing the current picture as well as the former one RAS that is nearest to the current RAS. It is a kind of reference picture and can provide reference for current encoding/decoding picture.

[0025] RL (Reference to Library) picture: is a picture that is encoded or decoded by only referencing to a library picture. In one example, the RL picture follows closely after the sequence header and provides random access functionality by first decoding the external library picture and then decoding the RL picture itself. In another example, the RL picture follows closely after the sequence header and the library picture, and provides random access functionality by first decoding the library picture and then decoding the RL picture itself. In another example, the RL picture follows the sequence header, wherein the supplemental enhancement information, or extension data, or user data, etc. are between the sequence header and the RL picture, and provides random access functionality by first decoding the library picture and then decoding the RL picture itself.

[0026] Library stream: is also referred to as library bitstream, which only contains the library picture. Main stream: is also referred to as main bitstream, which contains the picture that can reference to the library picture and does not contain the library picture. In one example, the library bitstream and main bitstream is spliced together to obtain a spliced bitstream.

[0027] Bitstream buffer: is used at the decoder side to store the input bitstream data. In one example, the capacity of the bitstream buffer is determined by the profile and level of the input bitstream.

[0028] Hypothetical bitstream buffer: is a virtual buffer, at the encoder side, that is used to simulate the state of the bitstream buffer, at the decoder side, which stores the input bitstream data. The hypothetical bitstream buffer does not actually store bitstream data. In one example, the hypothetical bitstream buffer records the change of data and estimates the data fulfillment level of the bitstream buffer at the decoder side by simulating the moving in and moving out operations of the bitstream data.

### Exemplary Embodiment 1

[0029] In a method of bitstream buffer verifier (BBV),

given a spliced bitstream, in which the main bitstream pictures have a frame rate of  $N$  ( $N > 0$ ) pictures per  $T$  ( $T > 0$ ) seconds, i.e. the presentation time interval of the main bitstream pictures is  $T/N$  seconds, there is an encoder, which has a hypothetical decoder that can decode at least  $N+1$  pictures in  $T$  seconds, processing the following operations. Note that the following decoding operations are not actually processed but simulated by the encoder to suppose that the picture data is moved out from the hypothetical bitstream buffer. The hypothetical bitstream buffer also does not actually process the operations of storing and moving out picture data but only records the change of picture data and the size of data in the hypothetical bitstream buffer. The operations are as follows:

1. The  $k$ -th ( $k \geq 0$ ) decoding instant is referred to as  $t(k)$ , wherein  $t(k) = k * T / (N+1)$ , and the  $m$ -th ( $m \geq 0$ ) presentation instant is referred to as  $t'(m)$ , wherein  $t'(m) = m * T / N$ .

2. The number of skipping decoding process is referred to as  $S$ , which is set to zero, i.e.  $S=0$ . The number of library pictures having been decoded is referred to as  $B$  ( $B \geq 0$ ), which is set to zero, i.e.  $B=0$ .

3. Importing the data of the sequence header, the extension and user data following the sequence header and the video editing code in the said spliced bitstream into the hypothetical bitstream buffer at the bitrate of  $R$  bit/s, wherein  $R > 0$ . In one example,  $R$  is a constant. In one example,  $R$  is different bitrates in different periods of time.

4. Importing the data of the said spliced bitstream starting from the picture header of the 0-th picture into the hypothetical bitstream buffer at the bitrate of  $R$  bit/s, and executing the following verifying operations:

1) Moving the coded data of the 0-th picture out from the hypothetical bitstream buffer at the time instant  $t(0)$ , wherein the said 0-th picture is a library picture that is not present, and setting  $B=B+1$ .

2) Moving the coded data of the 1-st picture out from the hypothetical bitstream buffer at the time instant  $t(1)$ , wherein the said 1-st picture is an RL picture. The 1-st picture is temporarily stored in a first hypothetical to-be-present buffer and present at the time instant  $t'(0)$  (Note that the said first hypothetical to-be-present buffer does not actually storing the picture data but only is used to indicate the presentation property of the said picture, which means that the said picture is the picture to be present and output at the next presentation time instant, wherein the said operations of presenting and outputting do not actually present or output the said picture data but are only used to indicate that the said picture has been processed and is no longer marked as stored in the said first hypothetical to-be-

present buffer. In one example, the said first hypothetical to-be-present buffer only contains one picture).

3) Performing loop operations for the k-th ( $k > 1$ ) picture,

A. If the said picture is a picture in the main bitstream, judging the range of the difference value between the decoding time instant and the presentation time instant of the said picture, i.e. judging the different value  $D$  between  $t(k+S)$  and  $t'(k-B)$ . In one example, judging the sequential order of the decoding instant of the said picture and the presentation time instant of the picture decoded before the said picture.

i. If  $D < T/N$ , moving the coded data of the k-th picture out from the hypothetical bitstream buffer at the time instant  $t(k+S)$ , wherein the said k-th picture is stored in the first hypothetical to-be-present buffer and is present at the time instant  $t'(k-B)$ .

ii. If  $T/N \leq D < 2 \cdot T/N$ , at the time instant  $t(k+S)$ ,

a. If  $D = T/N$ , presenting and outputting the picture stored in the said first hypothetical to-be-present buffer, and,

b. If  $T/N < D < 2 \cdot T/N$ , which means that the picture stored in the said first hypothetical to-be-present buffer has been present and output, moving the picture in a second hypothetical to-be-present buffer to the first hypothetical to-be-present buffer, moving the data of the k-th picture out from the hypothetical bitstream buffer and moving the said k-th picture into the second hypothetical to-be-present buffer, wherein the k-th picture is present at the time instant  $t'(k-B)$ . Note that the property of the said second hypothetical to-be-present buffer is similar as the said first hypothetical to-be-present buffer.

iii. If  $D > 2 \cdot T/N$ , at the time instant  $t(k+S)$ , accumulating the number of skipping decoding, i.e.  $S = S + 1$ , wherein no data is moved out from the hypothetical bitstream buffer and decoded, and setting  $k = k - 1$ , which means that the said picture will be verified at the next time instant.

B. If the said picture is library picture, moving the coded data of the k-th picture out from the hypothetical bitstream buffer for decoding at the time instant  $t(k+S)$ , wherein the said k-th picture is stored in the library picture buffer and is not present, and setting  $B = B + 1$ . Note that the property of the said library picture buffer is similar as the said first hypothetical to-be-present buffer.

4) Setting  $k = k + 1$  and going back to the operation 3) until all data of the bitstream is verified.

## Exemplary Embodiment 2

**[0030]** In a method of bitstream buffer verifier, the mechanism of corresponding bitstream operation is adopted at the decoder to timely decode the knowledge images interspersed in the spliced bitstream, but at the same time, the effect of neither overflow nor overflow should be ensured in the bitstream buffer with limited capacity. And the decoder can decode and display the images in the main bitstream according to the correct timing. Given that the frame rate of the main bitstream image in a given bitstream is  $N$  pictures per  $T$  seconds, that is, the presentation time interval of pictures is  $T/N$  seconds, then for a decoder that can decode at least  $N + 1$  frames of pictures in  $T$  seconds, the decoder performs the following operations:

1. The k-th ( $k \geq 0$ ) decoding instant is referred to as  $t(k)$ , wherein  $t(k) = k \cdot T / (N + 1)$ , and the m-th ( $m \geq 0$ ) presentation instant is referred to as  $t'(m)$ , wherein  $t(m) = m \cdot T / N$ .

2. The number of skipping decoding process is referred to as  $S$ , which is set to zero, i.e.  $S = 0$ . The number of library pictures having been decoded is referred to as  $B$  ( $B \geq 0$ ), which is set to zero, i.e.  $B = 0$ .

3. Selecting a random access point in the bitstream as the starting point.

4. Importing the data of the sequence header after the random access point, the extension and user data following the sequence head and the video editing code in the said spliced bitstream into the bitstream buffer at the bitrate of  $R$  bit/s, wherein  $R > 0$ . In one example,  $R$  is a constant. In one example,  $R$  is different bitrates in different time interval.

5. Importing the data of the said spliced bitstream starting from the picture header of the 0-th picture into the bitstream buffer at the bitrate of  $R$  bit/s, and processing the following verifying operations:

1) Moving the coded data of the 0-th picture out from the bitstream buffer at the time instant  $t(0)$ , wherein the said 0-th picture is a library picture that is not present, and setting  $B = B + 1$ .

2) Moving the coded data of the 1-st picture out from the bitstream buffer at the time instant  $t(1)$ ,

wherein the said 1-st picture is an RL picture. The 1-st picture is temporally stored in a first to-be-present buffer and present at the time instant  $t'(0)$ .

3) Performing loop operations for the k-th ( $k > 1$ ) picture,

**[0031]** A. If the said picture is not a library picture, judging the range of the difference value between the decoding time instant and the presentation time instant of the said picture, i.e. judging the different value  $D$  between  $t(k+S)$  and  $t'(k-B)$ . In one example, judging the sequential order of the decoding instant of the said picture and the presentation time instant of the picture decoded before the said picture.

i. If  $D < T/N$ , moving the coded data of the k-th picture out of the bitstream buffer at the time instant  $t(k+S)$  for decoding, wherein the said k-th picture is stored in the first to-be-present buffer and is present at the time instant  $t'(k-B)$ .

ii. If  $T/N \leq D < 2 \cdot T/N$ , at the time instant  $t(k+S)$ ,

a. If  $D = T/N$ , presenting and outputting the picture stored in the said first to-be-present buffer, and,

b. If  $T/N < D < 2 \cdot T/N$ , which means that the picture stored in the said first to-be-present buffer has been present and output, moving the picture in a second to-be-present buffer to the first to-be-present buffer, moving the coded data of the k-th picture out of the bitstream buffer for decoding and moving the said k-th picture into the second to-be-present buffer, wherein the k-th picture is present at the time instant  $t'(k-B)$ .

iii. If  $D > 2 \cdot T/N$ , at the time instant  $t(k+S)$ , accumulating the number of skipping decoding, i.e.  $S = S + 1$ , wherein no data is moved out from the bitstream buffer and decoded, and setting  $k = k - 1$ , which means that the said picture will be verified or decoded at the next time instant.

**[0032]** B. If the said picture is a library picture, moving the coded data of the k-th picture out from the bitstream buffer for decoding at the time instant  $t(k+S)$ , wherein the said k-th picture is stored in the library picture buffer and is not present, and setting  $B = B + 1$ .

**[0033]** 4) Setting  $k = k + 1$  and going back to the operation until all data of the bitstream is verified.

### Exemplary Embodiment 3

**[0034]** For the said method in Embodiment 2, an exemplary specific verification operation and the result of the data change in the bitstream buffer are shown in Figure 6. In this exemplary operation, let the frame rate of the spliced bitstream be  $N = f$  ( $f > 0$ ),  $T = 1$  second, that is,

the presentation time interval of pictures is  $T/N$  seconds, and the decoding capability of the decoder is  $T$  seconds to decode at least  $m = f + 1$  pictures. The decoder performs the following operations:

1. The k-th ( $k \geq 0$ ) decoding instant is referred to as  $t(k)$ , wherein  $t(k) = k \cdot T / (N + 1)$ , and the k-th presentation instant is referred to as  $t'(k)$ , wherein  $t'(k) = k \cdot T / N$ . And  $t(k, p)$  refers that the decoded picture at the time instant  $t(k)$  will be present at the time instant  $t'(p)$ . When the value of  $p$  is 'L', it means that the picture is a library knowledge picture which is not present. When the value of  $p$  is 'SK', it means that the decoding moment is skipped and no picture decoding is performed.

2. The number of skipping decoding process is referred to as  $S$ , which is set to zero, i.e.  $S = 0$ . The number of library pictures having been decoded is referred to as  $B$  ( $B \geq 0$ ), which is set to zero, i.e.  $B = 0$ .

3. Select a random access point in the bitstream as the starting point.

4. Importing the data of the sequence header after the random access point, the extension and user data following the sequence head and the video editing code in the said spliced bitstream into the bitstream buffer at the bitrate of  $R$  bit/s, wherein  $R > 0$ .

5. Importing the data of the said spliced bitstream starting from the picture header of the 0-th picture into the bitstream buffer at the bitrate of  $R$  bit/s, and processing the following verifying operations:

1) Moving the coded data of the 0-th picture out from the bitstream buffer at the time instant  $t(0, L)$ , wherein the said 0-th picture is a library picture that is not present, and setting  $B = B + 1$ , when  $B = 1$ .

2) Moving the coded data of the 1-st picture out from the bitstream buffer at the time instant  $t(1, 0)$ , wherein the said 1-st picture is an RL picture. The 1-st picture is temporally stored in a first to-be-present buffer and present at the time instant  $t'(0)$ .

3) Performing loop operations for the k-th ( $k > 1$ ) picture,

a. For the second picture, the picture is not a library picture, and  $D = t(k+S) - t'(k-B) = t(2) - t'(1) < T/N$ . Therefore, move the coded data of the second picture out from the bitstream buffer for decoding at the time instant  $t(2, 1)$ , wherein the said second picture is temporarily stored in the first to-be-present buffer and present at the time instant  $t'(1)$ ;

b. (Omit the operation of some non-library pictures in the middle)

c. For the m-th picture, the picture is not a library picture, and  $D = t(k+S) - t'(k-B)$



$B=t(m)-t'(m-1)=t(m)-t'(f)<T/N$ . Therefore, move the coded data of the  $m$ -th picture out from the bitstream buffer for decoding at the time instant  $t(m,f)$ , wherein the said  $m$ -th picture is temporarily stored in the first to-be-present buffer and present at the time instant  $t'(f)$ ;

d. For the  $m+1$ -th picture, the picture is not a library picture, and  $D=t(k+S)-t'(k-B)=t(m+1)-t'(m)=t(m+1)-t'(f+1)=T/N$ . Therefore, at the time instant  $t(m+1,f+1)$ , since  $D=T/N$ , the picture stored in the first to-be-present buffer is present output at the time instant  $t'(f)$ . And because the second to-be-present buffer is empty buffer with no buffer pictures at this time and move the coded data of the  $m+1$ -th picture out from the bitstream buffer for decoding, wherein the said  $m+1$ -th picture is temporarily stored in the second to-be-present buffer and present at the time instant  $t'(f+1)$ ;

e. For the  $m+2$ -th picture, the picture is not a library picture, and  $D=t(k+S)-t'(k-B)=t(m+2)-t'(m+1)=t(m+2)-t'(f+2)>T/N$ . Therefore, at the time instant  $t(m+2,f+2)$ , move the picture in the second to-be-present buffer into the first to-be-present buffer and move the coded data of the  $m+2$ -th picture out from the bitstream buffer for decoding, wherein the said  $m+2$ -th picture is temporarily stored in the second to-be-present buffer and present at the time instant  $t'(f+2)$ ;

f. For the  $m+3$ -th picture, the picture is not a library picture, and  $D=t(k+S)-t'(k-B)=t(m+3)-t'(m+2)=t(m+3)-t'(f+3)>T/N$ . Therefore, at the time instant  $t(m+3,f+3)$ , move the picture in the second to-be-present buffer into the first to-be-present buffer and move the coded data of the  $m+3$ -th picture out from the bitstream buffer for decoding, wherein the said  $m+3$ -th picture is temporarily stored in the second to-be-present buffer and present at the time instant  $t'(f+3)$ ;

g. (Omit the operation of some non-library pictures in the middle);

h. For the  $2m$ -th picture, the picture is not a library picture, and  $D=t(k+S)-t'(k-B)=t(2m)-t'(2m-1)=t(2m)-t'(2f+1)>T/N$ . Therefore, at the time instant  $t(2m,2f+1)$ , move the picture in the second to-be-present buffer into the first to-be-present buffer and move the coded data of the  $2m$ -th picture out from the bitstream buffer for decoding, wherein the said  $2m$ -th picture is temporarily stored in the second to-be-present buffer and present at the time in-

stant  $t'(2f+1)$ ;

i. For the  $2m+1$ -th picture, the picture is not a library picture, and  $D=t(k+S)-t'(k-B)=t(2m+1)-t'(2m)=t(2m+1)-t'(2f+2)=2*T/N$ . Therefore, at the time instant  $t(2m+1,SK)$ , the data is not moved from the bitstream buffer, no decoding is performed and the number of skipping decoding is accumulated, that is,  $S=S+1$ , at this moment  $S=1$ ; And set  $k=K-1$ , that is, wait for the next moment to verify or decode the picture. And wherein the said  $2m$ -th picture is temporarily stored in the second to-be-present buffer and present at the time instant  $t'(2f+1)$ ;

j. Operate the  $2m+1$ -th picture again, the picture is not a library picture, and  $D=t(k+S)-t'(k-B)=t(2m+2)-t'(2m)=t(2m+2)-t'(2f+2)>T/N$ . Therefore, at the time instant  $t(2m+1,SK)$ , move the picture in the second to-be-present buffer into the first to-be-present buffer and move the coded data of the  $2m+1$ -th picture out from the bitstream buffer for decoding, wherein the said  $2m+1$ -th picture is temporarily stored in the second to-be-present buffer and present at the time instant  $t'(2f+2)$ ;

k. Repeat the loop operation until all data of the bitstream is verified.

#### Exemplary Embodiment 4

[0035] A specific verification operation and the result of the data change in the bitstream buffer are shown in Figure 7. In this exemplary operation, difference from the above exemplary embodiment 3 is as follows:

For the  $2m+1$ -th picture, the picture is a library picture. Therefore, at the time instant  $t(2m+1,L)$ , move the coded data of the  $2m+1$ -th picture out from the bitstream buffer for decoding, wherein the said  $2m+1$ -th picture is temporarily stored in the library buffer and not present; set  $B=B+1$ .

#### Exemplary Embodiment 5

[0036] The difference between this embodiment and all the above-mentioned Embodiment 1 to 4 is that the decoder analyzes and obtains the number of main bitstream picture from the information picture header in the spliced bitstream, such as POC (picture order count) number, DOI (decoding order index) number, POI (presentation order index) number. And the sequence of the decoded picture is calculated according to the number of the main bitstream picture. Therefore, the library picture interspersed in the bitstream will affect neither the number of the main bitstream picture nor the present time instant  $t'(n)$  of the decoder of calculating the main bitstream picture. In this implementation method, there is

no need to perform the operation of accumulating the amount B of library pictures of the current picture that have been decoded before. That is, the decoder does not need to perform "record the amount of decoded library pictures as B, and B=0", nor does it need to perform the operation of "set B=B+1" when processing library pictures.

### Exemplary Embodiment 6

[0037] The difference between this embodiment and all the above-mentioned Embodiment 1 to 5 is that in one method of implementation, the picture in the spliced bitstream uses a low-delay reference structure, where  $t'(n)$  represents the present time instant of the main bitstream picture. And in another method of implementation, the picture in the spliced bitstream uses a non-low-delay reference structure, such as layered coding structure, the actual present time of pictures in the spliced bitstream is equal to  $t'(n)$  which refers to the present time instant plus the delayed-present time. At this time, the decoded picture buffer of the decoder will store these delayed-present pictures to ensure the present of pictures in the correct order.

### Exemplary Embodiment 7

[0038] Based on the above embodiment 1 to 6, this embodiment makes the adjustment to the size of the picture data in the spliced bitstream again. In one method of implementation, when the operation of skipping picture decoding occurs at a certain decoding moment, increase the rate at which the bitstream buffer data is moved out by increasing the data size of the subsequent pictures (for example, distributing the picture a higher quality or bitrate for the picture) to the data that enters into the bitstream buffer, so as to avoid the overflow of the bitstream buffer. In another method of implementation, when the operation of decoding the library picture occurs at a certain decoding moment, decrease the rate at which the bitstream buffer data is moved out by decreasing the data size of the subsequent pictures (for example, distributing the picture a lower quality or bitrate for the picture) to the data that enters into the bitstream buffer, so as to avoid the underflow of the bitstream buffer.

### Exemplary Embodiment 8

[0039] In one method of implementation, the difference between this embodiment and all the above-mentioned Embodiment 1 to 7 is that decoder can decode at least  $N+C$  frame images within  $T$  ( $T>0$ ) seconds, wherein the variable  $N$  ( $N>0$ )  $T$  refers to the number of pictures in the main bitstream that needs to be present and output in  $T$  seconds, and the  $C$  ( $C>0$ ) refers to the number of library pictures that need extra decoding in  $T$  seconds for example,  $C=1$  or  $C=2$ . In this method of implementation, the decoder uses  $t(k)$  to represent the  $k$ -th decoding

time instant, wherein  $t(k) = K * t / (N+C)$ ;  $T'(m)$  refers to the  $m$ -th present time instant, wherein  $t(m) = m * t / N$ .

### Exemplary Embodiment 9

[0040] The present exemplary embodiment realizes the method of bitstream verifying based on the AVS3 standard.

[0041] In one example, the bitstream stored in the bitstream buffer is a single bitstream or spliced bitstream. Typically, given a main bitstream with the value of LibraryPictureEnableFlag equal to 0, the said bitstream stored in the bitstream buffer is a single bitstream comprising the main bitstream. Given a main bitstream with the value of LibraryPictureEnableFlag equal to 1, the said bitstream stored in the bitstream buffer is a spliced bitstream combined with the main bitstream and the library bitstream that is referenced to by the main bitstream, wherein the library bitstream is interspersed in the main bitstream. Note that the said main bitstream does not contain library picture, and the said LibraryPictureEnableFlag indicates whether the main bitstream references to the library bitstream, wherein a value of 1 indicates that the main bitstream references to the library bitstream, i.e. the main bitstream is the main stream defined in the present invention, and a value of 0 indicates that the main bitstream does not reference to library bitstream.

[0042] In one example, for a spliced bitstream in non-low-delay condition, the method of moving data out from the bitstream buffer is that:

If the  $n$ -th picture is a library picture, the decoding time  $t(n)$  of the picture is equal to the decoding time  $t(n-1)$  of the previous picture plus one check time interval  $\Delta(n)$ , and  $t'(n) = t'(n-1)$ .

[0043] If the  $n$ -th picture is not a library picture, the reference decoding time of the picture is  $t'(n) = t'(n-1) + \Delta(n)$ :

—If  $t(n-1) + \Delta(n)$  is less than the reference decoding time  $t'(n)$  (In one example, the said reference decoding time is the presentation time mentioned in the above exemplary embodiments 1~8), then the decoding time  $t(n)$  of the picture is equal to the decoding time  $t(n-1)$  of the previous picture plus twice the check time interval  $\Delta(n)$ ;

—Otherwise, the decoding time  $t(n)$  of the picture is equal to the decoding time  $t(n-1)$  of the previous picture plus one check time interval  $\Delta(n)$ .

[0044] Note that  $t'(0) = t(0)$ , and the value of the said check time interval is determined by the picture data in the bitstream. In one example, the value of the said check time interval is equal to the reciprocal of frame rate. In one example, the value of the said check time interval is equal to the product of the reciprocal of frame rate multiplied by  $n$ , wherein  $n$  is non-zero and, for example, is equal to 2, 1.5, 0.5, etc.

[0045] In one example, for a spliced bitstream in low-

delay condition, the method of moving data out from the bitstream buffer is that:

If the n-th picture is a library picture, the decoding time  $t(n)$  of the picture is equal to the decoding time  $t(n-1)$  of the previous picture plus one check time interval  $\Delta(n)$ , and plus the product of BbvCheckTimes multiplied by the picture period, and  $t'(n)=t'(n-1)$ .

If the n-th picture is not a library picture, the reference decoding time of the picture is  $t'(n)=t'(n-1)+\Delta(n)$ :

—If  $t(n-1)+\Delta(n)$  is less than the reference decoding time  $t'(n)$ , then the decoding time  $t(n)$  of the picture is equal to the decoding time  $t(n-1)$  of the previous picture plus twice the check time interval  $\Delta(n)$ , and plus the product of BbvCheckTimes multiplied by the picture period;

—Otherwise, the decoding time  $t(n)$  of the picture is equal to the decoding time  $t(n-1)$  of the previous picture plus one check time interval  $\Delta(n)$ , and plus the product of BbvCheckTimes(n) multiplied by the picture period.

**[0046]** Note that  $t'(0)=t(0)$ , and the value of the said check time interval is determined by the picture data in the bitstream. In one example, the value of the said check time interval is equal to the reciprocal of frame rate. In one example, the value of the said check time interval is equal to the product of the reciprocal of frame rate multiplied by n, wherein n is non-zero and, for example, is equal to 2, 1.5, 0.5, etc. The BbvCheckTimes is calculated according to the data of the bitstream, indicating the checking times of the bitstream buffer

**[0047]** In one example, for a spliced bitstream, the check time interval  $\Delta(n)$  is defined as follows: Let the reciprocal of the sum of frame rate and 1 is T, and the reciprocal of frame rate be T'. The check time interval  $\Delta(n)$  of the BBV buffer is equal to T, and  $\Delta'(n)$  is determined by the non-library picture output after the previous one picture is decoded.

**[0048]** If the value of progressive\_sequence is '1' and the value of field\_coded\_sequence is '0':

—If the value of repeat\_first\_field of the output picture is '0',  $\Delta(n)$  is equal to T.

—If the value of repeat\_first\_field of the output picture is '1' and the value of top\_field\_first is '0',  $\Delta(n)$  is equal to 2T.

—If the value of repeat\_first\_field of the output picture is '1' and the value of top field first is '1',  $\Delta(n)$  is equal to 3T.

**[0049]** If the value of progressive\_sequence is '0' and the value of field\_coded\_sequence is '0':

—If the value of repeat\_first\_field of the output picture is '0',  $\Delta(n)$  is equal to T.

—If the value of repeat\_first\_field of the output picture is '1',  $\Delta(n)$  is equal to 1.5T.

**[0050]** If the value of progressive\_sequence is '0' and the value of field\_coded\_sequence is '1',  $\Delta(n)$  is equal to 0.5T.

**[0051]** Note that, the said progressive\_sequence, field\_coded\_sequence, repeat\_first\_field, top field first are syntax elements in a bitstream indicating the property of the bitstream. The value of the syntax is obtained by parsing the bitstream. The progressive\_sequence indicates whether the picture in the bitstream uses progressive scanning. The field\_coded\_sequence indicates whether the picture in the bitstream uses field scanning, i.e. a picture is constructed by field frames. The repeat\_first\_field indicates whether the bitstream repeats the first field frame. The top\_field\_first indicates whether the first field frame in the bitstream is a top field frame.

### Exemplary Embodiment 10

**[0052]** The present exemplary embodiment realizes the method of bitstream verifying based on the AVS3 standard. Compared with the exemplary embodiment 9, the present exemplary embodiment exploits different reasons for determination.

**[0053]** In one example, the bitstream stored in the bitstream buffer does not contain library bitstream or does contain library bitstream. Typically, given a main bitstream with the value of LibraryPictureEnableFlag equal to 0, the said bitstream stored in the bitstream buffer contains the main bitstream and does not contain the library bitstream. Given a main bitstream with the value of LibraryPictureEnableFlag equal to 1, the said bitstream stored in the bitstream buffer is combined with the main bitstream and the library bitstream that is referenced to by the main bitstream, wherein the library bitstream is interspersed in the main bitstream in one example, or the library bitstream is ahead of the main bitstream in another example. Note that the said main bitstream does not contain library picture, and the said LibraryPictureEnableFlag indicates whether the main bitstream references to the library bitstream, wherein a value of 1 indicates that the main bitstream references to the library bitstream, i.e. the main bitstream is the main stream defined in the present invention, and a value of 0 indicates that the main bitstream does not reference to library bitstream.

**[0054]** The time instant when the coded data of the n-th picture is moved out from the BBV buffer is the decoding time instant of the n-th picture. The decoding time instant  $t(0)$  of the 1-st picture of the video sequence is equal to the time instant, when the picture start code of the 1-st picture enters into the BBV buffer, plus  $tt(0)$ .  $tt(0)$  is the time interval between the time instant when the picture start code of the 1-st picture enters into the BBV buffer and the decoding time of the 1-st picture. The de-

termination of the decoding time instant  $t(n)$  of the  $n$ -th picture and the method used to move the coded data out from the BBV buffer have the following examples, and other examples can use similar ways together with different descriptions or judgement conditions.

**[0055]** In one example, for a spliced bitstream in non-low-delay condition, the method of moving data out from the bitstream buffer is that:

For a decoded bitstream that does not contain a library stream, the decoding time  $t(n)$  of the  $n$ -th picture is equal to the decoding time  $t(n-1)$  of the previous picture plus one check time interval  $\Delta(n)$ . For a decoded bitstream containing a library stream, if the  $n$ -th picture is a library picture, the reference decoding time of the picture  $t'(n)=t'(n-1)$ , where  $t'(0)=t(0)$ ; the decoding time  $t(n)$  of the picture is equal to the decoding time  $t(n-1)$  of the previous picture plus one check time interval  $\Delta(n)$ .

For a decoded bitstream containing a library stream, if the  $n$ -th picture is not a library picture, the reference decoding time of the picture is  $t'(n)=t'(n-1)+\Delta'(n)$ , where  $t'(0)=t(0)$ ; the decoding time  $t(n)$  of the picture is as follows:

——If  $t(n-1)+\Delta(n)$  is less than the reference decoding time  $t'(n)-\Delta'(n)-\Delta'(n-1)$ , then  $t(n)$  is equal to the decoding time  $t(n-1)$  of the previous picture plus twice the check time interval  $\Delta(n)$ ;

——Otherwise,  $t(n)$  is equal to the decoding time  $t(n-1)$  of the previous picture plus one check time interval  $\Delta(n)$ .

**[0056]** The check time interval  $\Delta(n)$  and the hypothetical check time interval  $\Delta'(n)$  are defined in the following paragraphs.

**[0057]** At the decoding time  $t(n)$  of each picture, the fullness of BBV buffer shall be less than BBS. The fullness  $B(n)$  of BBV buffer shall be equal to or greater than  $f(n)$ , wherein  $f(n)$  is the size of the bitstream data of the  $n$ -th picture; otherwise, BBV buffer is underflow, code bitstreams conforming to the present exemplary embodiment should not underflow.

**[0058]** At the decoding time  $t(n)$  of each picture, remove the coded data of the picture from BBV buffer and decode it instantaneously.

**[0059]** In one example, for a spliced bitstream in low-delay condition, the method of moving data out from the bitstream buffer is that:

For a decoded bitstream that does not contain a library stream, the decoding time  $t(n)$  of the  $n$ -th picture is equal to the decoding time  $t(n-1)$  of the previous picture plus one check time interval  $\Delta(n)$ , and plus the product of  $BbvCheckTimes$  multiplied by the picture period.

For a decoded bitstream containing a library stream,

if the  $n$ -th picture is a library picture, the reference decoding time of the picture is  $t'(n)=t'(n-1)$ , wherein  $t'(0)=t(0)$ ; the decoding time  $t(n)$  of the picture is equal to the decoding time  $t(n-1)$  of the previous picture plus one check time interval  $\Delta(n)$ , and plus the product of  $BbvCheckTimes$  multiplied by the picture period, wherein the  $BbvCheckTimes$  is calculated according to the data of the bitstream, indicating the checking times of the bitstream buffer.

For a decoded bitstream containing a library stream, if the  $n$ -th picture is not a library picture, the reference decoding time of the picture is  $t'(n)=t'(n-1)+\Delta'(n)$ , wherein  $t'(0)=t(0)$ ; the decoding time  $t(n)$  of the picture is as follows:

——If  $t(n-1)+\Delta(n)$  is less than the reference decoding time  $t'(n)-\Delta'(n)-\Delta'(n-1)$ , then  $t(n)$  is equal to the decoding time  $t(n-1)$  of the previous picture plus twice the check time interval  $\Delta(n)$ , and plus the product of  $BbvCheckTimes$  multiplied by the picture period;

——Otherwise,  $t(n)$  is equal to the decoding time  $t(n-1)$  of the previous picture plus one check time interval  $\Delta(n)$ , and plus the product of  $BbvCheckTimes(n)$  multiplied by the picture period.

**[0060]** The check time interval  $\Delta(n)$  and the hypothetical check time interval  $\Delta'(n)$  are defined in the following paragraphs. If the value of field\_coded\_sequence is '1', then picture period is equal to 0.5 times the reciprocal of frame rate; if the value of field\_coded\_sequence is '0', then picture period is equal to the reciprocal of frame rate.

**[0061]** At the decoding time  $t(n)$  of each picture, the fullness of BBV buffer shall be less than BBS. All coded data of the picture shall be in BBV buffer, and then the picture shall be removed instantaneously.

**[0062]** If  $BbvCheckTimes$  is greater than 0, current decoded picture is defined as a "big picture". The last picture of a video sequence shall not be a "big picture".

**[0063]** The check time interval  $\Delta(n)$  and the hypothetical check time interval  $\Delta'(n)$  is defined as follows: Let the reciprocal of frame rate be  $T$ , the reciprocal of the sum of frame rate and 1 is  $D$ ; In another example,  $D$  is the reciprocal of the sum of the frame rate and  $k$ , wherein  $k$  is the difference value between the frame rate and the number of pictures that can be decoded by a decoder in 1 second. number of extra pictures decoded by the decoder. If the decoded bitstream does not contain a library stream, then  $P$  is equal to  $T$ ; if the decoded bitstream contains a library stream and a sequence stream, then  $P$  is equal to  $D$ .

**[0064]** The check time interval  $\Delta(n)$  and the assumed check time interval  $\Delta'(n)$  of BBV buffer are determined by the non-library picture output after the  $(n-1)$ th picture is decoded.

**[0065]** If the value of progressive\_sequence is '1' and the value of field\_coded\_sequence is '0':

—If the value of repeat\_first\_field of the output picture is '0', then  $\Delta(n)$  is equal to  $P$  and  $\Delta'(n)$  is equal to  $T$ .

—If the value of repeat\_first\_field of the output picture is '1' and the value of top\_field\_first is '0', then  $\Delta(n)$  is equal to  $2P$  and  $\Delta'(n)$  is equal to  $2T$ .

—If the value of repeat\_first\_field of the output picture is '1' and the value of top field first is '1', then  $\Delta(n)$  is equal to  $3P$  and  $\Delta'(n)$  is equal to  $3T$ .

**[0066]** If the value of progressive\_sequence is '0' and the value of field\_coded\_sequence is '0':

—If the value of repeat first field of the output picture is '0', then  $\Delta(n)$  is equal to  $P$  and  $\Delta'(n)$  is equal to  $T$ .

—If the value of repeat\_first\_field of the output picture is '1', then  $\Delta(n)$  is equal to  $1.5P$  and  $\Delta'(n)$  is equal to  $1.5T$ .

**[0067]** If the value of progressive\_sequence is '0' and the value of field\_coded\_sequence is '1', then  $\Delta(n)$  is equal to  $0.5P$  and  $\Delta'(n)$  is equal to  $0.5T$ .

**[0068]** Note that, the said progressive\_sequence, field\_coded\_sequence, repeat\_first\_field, top\_field\_first are syntax elements in a bitstream indicating the property of the bitstream. The value of the syntax is obtained by parsing the bitstream. The progressive\_sequence indicates whether the picture in the bitstream uses progressive scanning. The field\_coded\_sequence indicates whether the picture in the bitstream uses field scanning, i.e. a picture is constructed by field frames. The repeat\_first\_field indicates whether the bitstream repeats the first field frame. The top\_field\_first indicates whether the first field frame in the bitstream is a top field frame.

## Claims

1. A method of bitstream verifying, comprising:

1) for the coded data of a current picture in a bitstream combined with main bitstream and library bitstream, executing one of the following operations:

- a. if the current picture belongs to the main bitstream, deciding whether to move the coded data of the current picture out from a hypothetical bitstream buffer or not according to the difference value between the decoding time instant of the current picture and the presentation time instant of a previous picture that has been decoded before the current picture, wherein the previous picture belongs to the main bitstream;
- b. if the current picture belongs to the library bitstream, moving the coded data of the cur-

rent picture out from the hypothetical bitstream buffer, according to the decoding time instant of the current picture;

2) checking the data fulfillment level of the hypothetical bitstream buffer, verifying whether the said bitstream is qualified, according to whether the data fulfillment level exceeds the upper limit and lower limit of the capacity of the hypothetical bitstream buffer.

2. The method according to claim 1, wherein the operation of deciding whether to move the coded data of the current picture out from a hypothetical bitstream buffer or not according to the difference value between the decoding time instant of the current picture and the presentation time instant of a previous picture that has been decoded before the current picture, is executing one of the following operations:

1) if the decoding time instant of the current picture is not earlier than the presentation time instant of a second previous picture that is the second nearest one decoded before the current picture, moving the coded data of the current picture out from the hypothetical bitstream buffer at the decoding time instant of the current picture;

2) if the decoding time instant of the current picture is earlier than the presentation time instant of a second previous picture that is the second nearest one decoded before the current picture, do not move coded data out from the hypothetical bitstream buffer at the decoding time instant of the current picture.

3. A method of decoding, executing one of the following operations for the coded data of a current picture in a bitstream storing in a bitstream buffer, wherein the said bitstream is combined with main bitstream and library bitstream:

- a. if the current picture belongs to the main bitstream, deciding whether to move the coded data of the current picture out from the bitstream buffer for decoding or not according to the difference value between the decoding time instant of the current picture and the presentation time instant of a previous picture that has been decoded before the current picture, wherein the previous picture belongs to the main bitstream;
- b. if the current picture belongs to the library bitstream, moving the coded data of the current picture out from the bitstream buffer for decoding, according to the decoding time instant of the current picture.

4. The method according to claim 3, wherein the oper-

ation of deciding whether to move the coded data of the current picture out from the bitstream buffer for decoding or not according to the difference value between the decoding time instant of the current picture and the presentation time instant of a previous picture that has been decoded before the current picture, is executing one the of the following operations:

- 1) if the decoding time instant of the current picture is not earlier than the presentation time instant of a second previous picture that is the second nearest one decoded before the current picture, moving the coded data of the current picture out from the bitstream buffer for decoding at the decoding time instant of the current picture, and moving the decoded current picture into a to-be-present buffer;
- 2) if the decoding time instant of the current picture is earlier than the presentation time instant of a second previous picture that is the second nearest one decoded before the current picture, do not move coded data out from the bitstream buffer at the decoding time instant of the current picture.

5. The method according to claim 4, wherein the operation of moving the decoded current picture into a to-be-present buffer is executing one of the following operations:

- 1) if the decoding time instant of the current picture is not earlier than the presentation time instant of a first previous picture that is the first nearest one decoded before the current picture, moving the said decoded current picture into a first to-be-present buffer;
- 2) if the decoding time instant of the current picture is not earlier than the presentation time instant of the second previous picture that is the second nearest one decoded before the current picture and is earlier than the presentation time instant of the first previous picture that is the first nearest one decoded before the current picture, moving a decoded picture from a second to-be-present buffer into the first to-be-present buffer and moving the said decoded current picture into the second to-be-present buffer.

6. The method according to claim 3, wherein the decoded version of the current picture is moved into a library picture buffer if the current picture belongs to the library bitstream.

7. An apparatus of bitstream verifying, comprising:

a processor,  
a memory, and

one or more programs executing the following methods:

- 1) for the coded data of a current picture in a bitstream combined with main bitstream and library bitstream, wherein the said bitstream is stored in the memory, the processor executes one of the following operations:

- a. if the current picture belongs to the main bitstream, the processor decides whether to move the coded data of the current picture out from a hypothetical bitstream buffer or not according to the difference value between the decoding time instant of the current picture and the presentation time instant of a previous picture that has been decoded before the current picture, wherein the previous picture belongs to the main bitstream;
- b. if the current picture belongs to the library bitstream, the processor moves the coded data of the current picture out from the hypothetical bitstream buffer, according to the decoding time instant of the current picture;

- 2) the processor checks the data fulfillment level of the hypothetical bitstream buffer, verifies whether the said bitstream is qualified, according to whether the data fulfillment level exceeds the upper limit and lower limit of the capacity of the hypothetical bitstream buffer.

8. The apparatus according to claim 7, wherein the processor deciding whether to move the coded data of the current picture out from a hypothetical bitstream buffer or not according to the difference value between the decoding time instant of the current picture and the presentation time instant of a previous picture that has been decoded before the current picture, is executing one of the following operations:

- 1) if the decoding time instant of the current picture is not earlier than the presentation time instant of a second previous picture that is the second nearest one decoded before the current picture, the processor moves the coded data of the current picture out from the hypothetical bitstream buffer at the decoding time instant of the current picture;
- 2) if the decoding time instant of the current picture is earlier than the presentation time instant of a second previous picture that is the second nearest one decoded before the current picture,

the processor does not move coded data out from the hypothetical bitstream buffer at the decoding time instant of the current picture.

instant of the current picture.

9. An apparatus of decoding, comprising: 5

a processor,  
a memory, and  
one or more programs executing the following methods: 10  
the processor executes one of the following operations for the coded data of a current picture in a bitstream entering into a bitstream buffer in the memory, wherein the said bitstream is combined with main bitstream and library bitstream: 15

- a. if the current picture belongs to the main bitstream, the processor decides whether to move the coded data of the current picture out from the bitstream buffer for decoding or not according to the difference value between the decoding time instant of the current picture and the presentation time instant of a previous picture that has been decoded before the current picture, wherein the previous picture belongs to the main bitstream; 20 25
- b. if the current picture belongs to the library bitstream, the processor moves the coded data of the current picture out from the bitstream buffer for decoding, according to the decoding time instant of the current picture. 30

10. The apparatus according to claim 9, wherein the processor deciding whether to move the coded data of the current picture out from the bitstream buffer for decoding or not according to the difference value between the decoding time instant of the current picture and the presentation time instant of a previous picture that has been decoded before the current picture, is executing one of the following operations: 35 40

- 1) if the decoding time instant of the current picture is not earlier than the presentation time instant of a second previous picture that is the second nearest one decoded before the current picture, the processor moves the coded data of the current picture out from the bitstream buffer for decoding at the decoding time instant of the current picture, and moves the decoded current picture into a to-be-present buffer; 45 50
- 2) if the decoding time instant of the current picture is earlier than the presentation time instant of a second previous picture that is the second nearest one decoded before the current picture, the processor does not move coded data out from the bitstream buffer at the decoding time 55

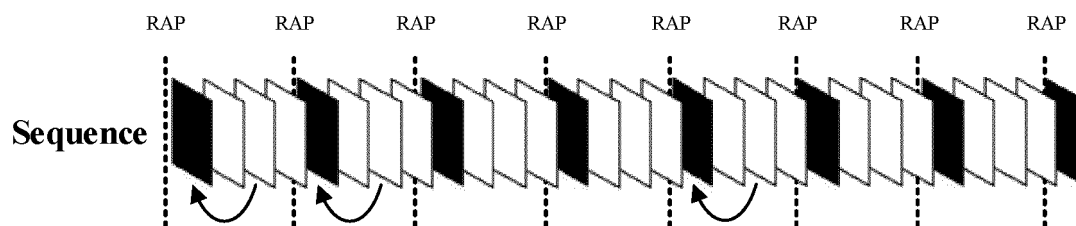


Figure 1

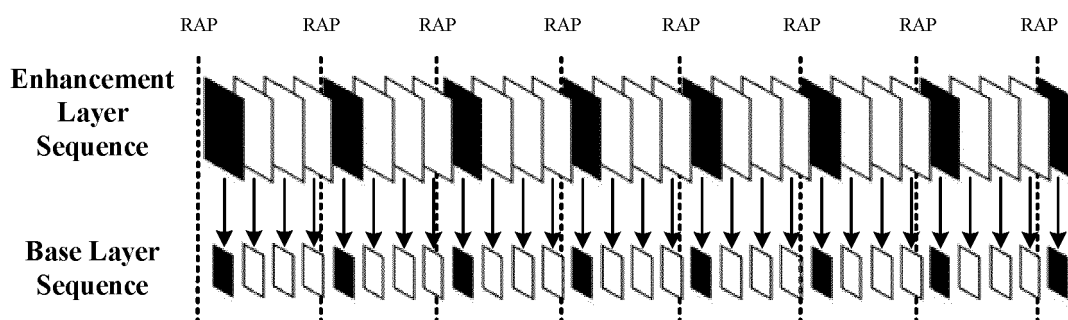


Figure 2

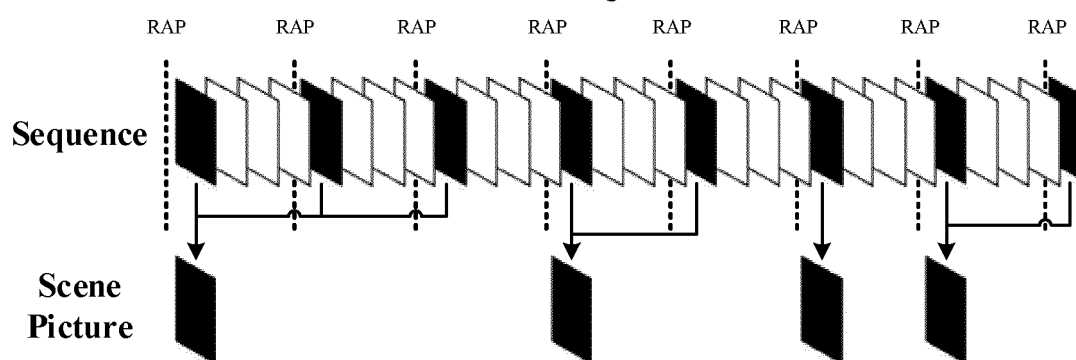


Figure 3

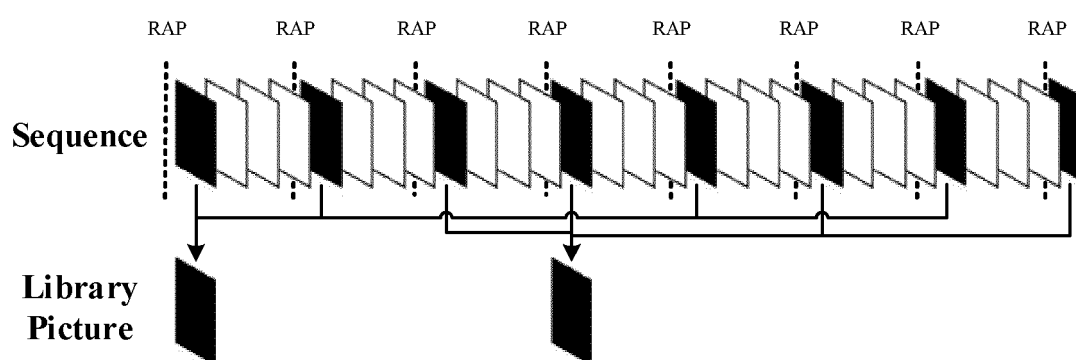


Figure 4



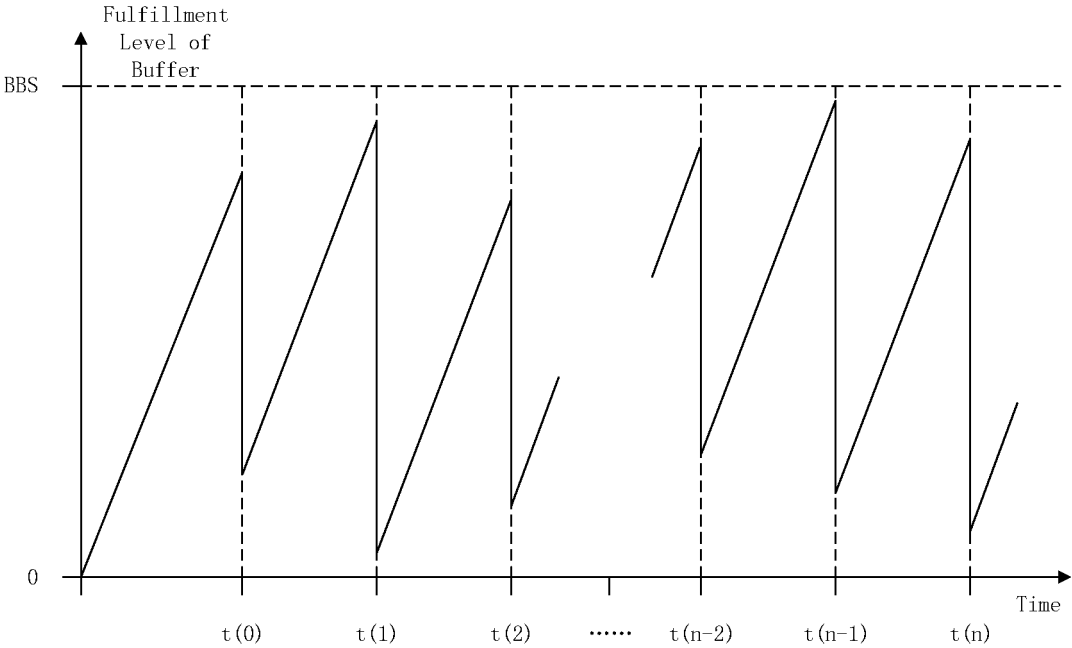


Figure 5

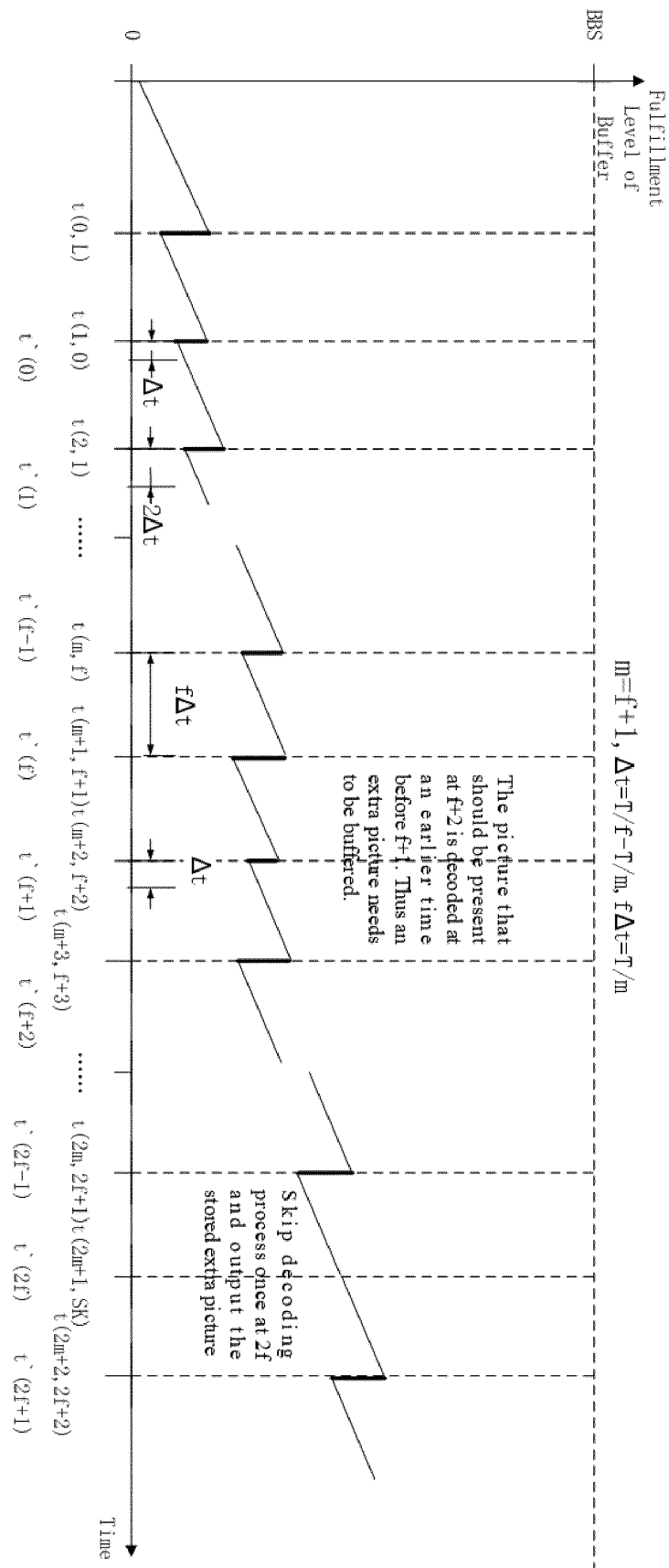


Figure 6

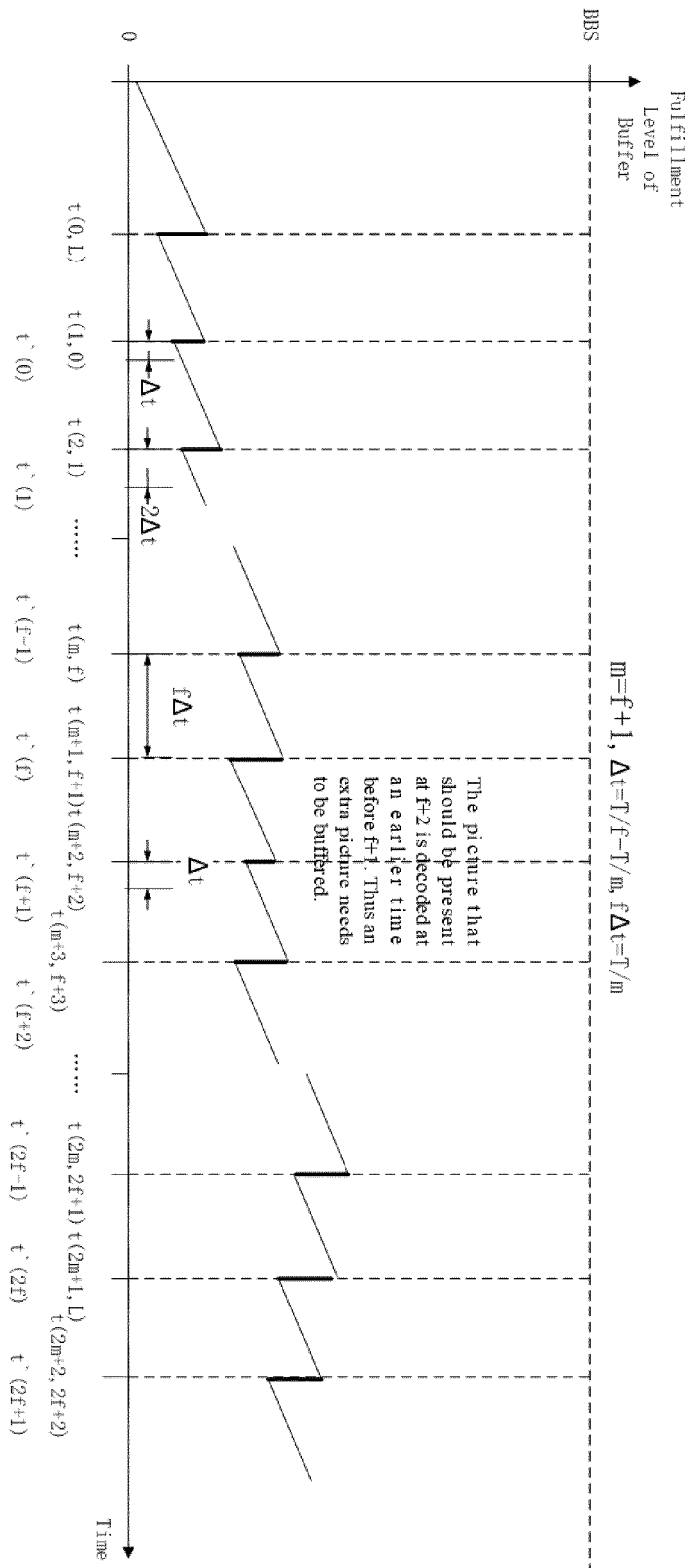


Figure 7

## INTERNATIONAL SEARCH REPORT

International application No.

PCT/CN2020/072222

<b>A. CLASSIFICATION OF SUBJECT MATTER</b> H04N 19/423(2014.01)i; H04N 19/44(2014.01)i  According to International Patent Classification (IPC) or to both national classification and IPC																								
<b>B. FIELDS SEARCHED</b>  Minimum documentation searched (classification system followed by classification symbols) H04N19  Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched																								
Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)  EPTXT; USTXT; VEN; WOTXT; CNABS; CNTXT: 位流, 检验, 检测, 监测, 码流, 解码, 缓存, 缓冲, 虚拟, 假设, 参考, 图像, 虚拟参考解码器, 假设参考解码器, 模拟参考解码器, 假想参考解码器, 假设解码器, 虚拟解码器, 解码器多层编码, 知识库, 知识流, 参考图像, 参考层, 解码时刻, 解码时间, 显示时刻, 显示时间, 移出, 移除, 导出, 上溢, 下溢, 溢出, 下限, 上限, bitstream, monitor, decode, buffer, cache, hypothetical, reference, virtual, simulation, image, hypothetical reference decoder, knowledge, reference image, time, display, move, shift, overflow																								
<b>C. DOCUMENTS CONSIDERED TO BE RELEVANT</b> <table border="1"> <thead> <tr> <th>Category*</th> <th>Citation of document, with indication, where appropriate, of the relevant passages</th> <th>Relevant to claim No.</th> </tr> </thead> <tbody> <tr> <td>A</td> <td>CN 1251004 A (PANASONIC CORPORATION) 19 April 2000 (2000-04-19) entire document</td> <td>1-10</td> </tr> <tr> <td>A</td> <td>CN 101317459 A (NOKIA CORPORATION) 03 December 2008 (2008-12-03) entire document</td> <td>1-10</td> </tr> <tr> <td>A</td> <td>CN 108668132 A (MEDIATEK SINGAPORE PTE. LTD.) 16 October 2018 (2018-10-16) entire document</td> <td>1-10</td> </tr> <tr> <td>A</td> <td>CN 105075269 A (SHARP CORPORATION) 18 November 2015 (2015-11-18) entire document</td> <td>1-10</td> </tr> <tr> <td>A</td> <td>CN 103460696 A (SONY CORPORATION) 18 December 2013 (2013-12-18) entire document</td> <td>1-10</td> </tr> <tr> <td>A</td> <td>WO 2018217907 A1 (QUALCOMM INCORPORATED) 29 November 2018 (2018-11-29) entire document</td> <td>1-10</td> </tr> <tr> <td>A</td> <td>US 2004005007 A1 (CONEXANT SYSTEMS, INC.) 08 January 2004 (2004-01-08) entire document</td> <td>1-10</td> </tr> </tbody> </table>	Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.	A	CN 1251004 A (PANASONIC CORPORATION) 19 April 2000 (2000-04-19) entire document	1-10	A	CN 101317459 A (NOKIA CORPORATION) 03 December 2008 (2008-12-03) entire document	1-10	A	CN 108668132 A (MEDIATEK SINGAPORE PTE. LTD.) 16 October 2018 (2018-10-16) entire document	1-10	A	CN 105075269 A (SHARP CORPORATION) 18 November 2015 (2015-11-18) entire document	1-10	A	CN 103460696 A (SONY CORPORATION) 18 December 2013 (2013-12-18) entire document	1-10	A	WO 2018217907 A1 (QUALCOMM INCORPORATED) 29 November 2018 (2018-11-29) entire document	1-10	A	US 2004005007 A1 (CONEXANT SYSTEMS, INC.) 08 January 2004 (2004-01-08) entire document	1-10
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Date of the actual completion of the international search  <b>30 March 2020</b>	Date of mailing of the international search report  <b>08 April 2020</b>																							
Name and mailing address of the ISA/CN  <b>China National Intellectual Property Administration No. 6, Xitucheng Road, Jimenqiao Haidian District, Beijing 100088 China</b>  Facsimile No. <b>(86-10)62019451</b>	Authorized officer    Telephone No.																							

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## INTERNATIONAL SEARCH REPORT

International application No.

PCT/CN2020/072222

C. DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	左旭光 (ZUO, Xuguang). "基于多层结构的视频编码研究 (Research on Multi-Layer-Based Video Coding)" 中国博士学位论文全文数据库信息科技辑 (China Doctoral Dissertations Full-Text Database), No. no. 11, 15 November 2017 (2017-11-15), entire document	1-10

Form PCT/ISA/210 (second sheet) (January 2015)

**INTERNATIONAL SEARCH REPORT**  
**Information on patent family members**

International application No.

**PCT/CN2020/072222**

Patent document cited in search report	Publication date (day/month/year)	Patent family member(s)	Publication date (day/month/year)
CN 1251004 A	19 April 2000	DE 69930216 D1 EP 0994627 A3 EP 0994627 A2 CN 1198464 C US 6542549 B1 ES 2259827 T3 KR 20000034997 A EP 0994627 B1 DE 69930216 T2 KR 100357233 B1	04 May 2006 26 July 2000 19 April 2000 20 April 2005 01 April 2003 16 October 2006 26 June 2000 08 March 2006 07 December 2006 18 October 2002
CN 101317459 A	03 December 2008	EP 1949701 A1 WO 2007042914 A1 KR 20080066784 A JP 2009512306 A US 2007086521 A1	30 July 2008 19 April 2007 16 July 2008 19 March 2009 19 April 2007
CN 108668132 A	16 October 2018	None	
CN 105075269 A	18 November 2015	WO 2014162954 A1 US 2018115780 A1 TW 201448574 A US 9912959 B2 TW 1646826 B CN 105075269 B JP WO2014162954 A1 JP 6352248 B2 EP 2996339 A4 US 2016057439 A1 EP 2996339 A1 HK 1217256 A1	09 October 2014 26 April 2018 16 December 2014 06 March 2018 01 January 2019 03 July 2018 16 February 2017 04 July 2018 02 November 2016 25 February 2016 16 March 2016 30 December 2016
CN 103460696 A	18 December 2013	WO 2012137656 A1 US 2017310975 A1 US 9723304 B2 CN 103460696 B US 2014016712 A1 US 10171817 B2 JP 5787135 B2 JP 2012222531 A	11 October 2012 26 October 2017 01 August 2017 22 December 2017 16 January 2014 01 January 2019 30 September 2015 12 November 2012
WO 2018217907 A1	29 November 2018	US 2018343471 A1 CN 110603812 A TW 201907731 A	29 November 2018 20 December 2019 16 February 2019
US 2004005007 A1	08 January 2004	EP 1518403 A4 AU 2003247605 A1 US 7257162 B2 EP 1518403 A2 WO 2004006446 A2 WO 2004006446 A3 AU 2003247605 A8	18 March 2009 23 January 2004 14 August 2007 30 March 2005 15 January 2004 26 February 2004 23 January 2004

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